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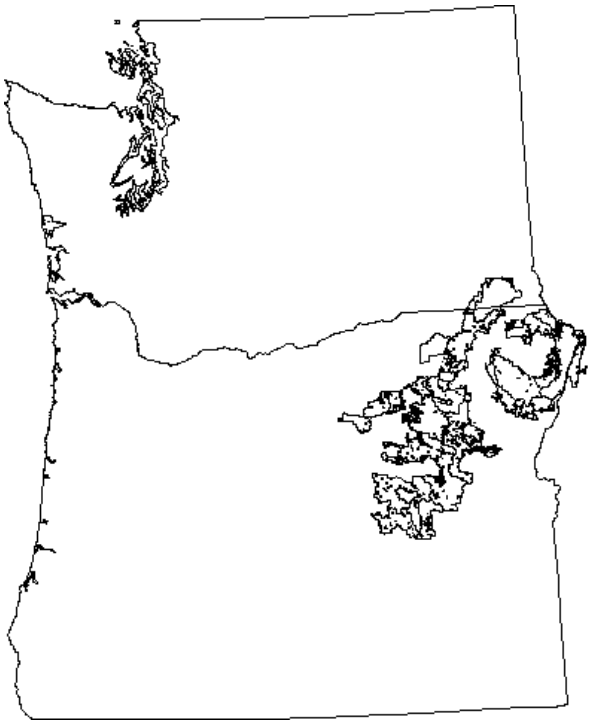
Johnson's Hairstreak Butterfly (*Callophrys johnsoni*) in the Blue Mountains

Lia H. Spiegel

Johnson's hairstreak larva on ponderosa pine dwarf mistletoe-infected branch.



The Johnson's hairstreak butterfly (*Callophrys johnsoni*) is on the Regional Forester's sensitive species list (http://www.fs.fed.us/r6/sfpnw/issssp/agency-policy/). It is known to occur from southwestern British Columbia to central California (Scott 1986). It is documented from over 80 sites in Oregon and Washington but about a third of these records are over 40 years old or do not have specific location information (Ray Davis, pers. com.). A disjunct population occurs on the Oregon/Idaho border in Baker and Union Counties in Oregon and in Boise and Adams Counties in Idaho (http://www.butterfliesandmoths.org/species/Callophrys-johnsoni).

There are one to two generations a year depending on climate. Not much is known about the population in the Blue Mountains but two generations are suspected. Pupae overwinter, adults are present as early as mid-April until early July, and eggs are laid singly directly on host plants (James & Nunnallee 2011). Larvae feed from early to mid-summer (Fig. 1).

The Johnson's hairstreak larvae feed exclusively on the aerial shoots of dwarf mistletoe plants (*Arceuthobium spp*.) (LaBonte et al., 2001). Parasitic dwarf mistletoe species are highly specialized and adapted to their host species. Most species are limited to one or two primary host trees, with infection in one or two other tree species occurring rarely (Hawksworth & Wiens, 1996). The Johnson's hairstreak is known to feed on three species of dwarf mistletoe. The Johnson's hairstreaks in the Cascades, Sierras and on the coast have been found feeding on dwarf mistletoe of western hemlock (*Tsuga heterophylla*) and grey (digger) pine (*Pinus sabiniana*) (Kelson & Minno, 1983; Shields, 1965), while those found in northeastern Oregon have been found feeding on western dwarf mistletoe (*A. campylopodum*) on ponderosa pine (*P. ponderosa*) (McCorkle, pers. com.). Other dwarf mistletoes occurring in the Blue Mountains include dwarf mistletoes on lodgepole pine, western larch, and Douglas-fir, and these are possible hosts.

Because hairstreak eggs are laid singly directly on larval foodplants, it is likely that plant size is a factor in host selection. Dwarf mistletoe species vary considerably in size and growth form/habit. Larger plants will enable larvae to feed to maturity without having to move from plant to plant and increase exposure to predators. The confirmed hosts for hairstreaks are some of the larger dwarf mistletoe plants in the United States. McCorkle believes that Johnson's hairstreaks prefer large dwarf mistletoe clumps as they provide more habitat and food (pers. com.).

To determine any additional likely larval hosts in the Blue Mountains, the average size of dwarf mistletoe species in the Blue Mountains and the more common thicket hairstreak hosts are compared in Table 1. The thicket hairstreak (*Callophrys spinetorum*) is the only other hairstreak in the Northwest that feeds exclusively on dwarf mistletoe (Guppy & Shepard 2001). The thicket hairstreak larva is so similar to the Johnson's they are commonly believed indistinguishable (Scott 1986). The thicket hairstreak is more widespread and common and has been reared from 9 species of dwarf mistletoe, while the Johnson's has been confirmed to feed on three species.

Mean shoot height of all confirmed hosts for hairstreaks is at least 4 cm (Hawksworth & Wiens 1996; Shields 1965).

Table 1: Sizes of confirmed Dwarf mistletoe hosts of Johnson's hairstreak (blue text), of thicket hairstreak (orange text and *), and of other possible Dwarf mistletoe hosts of Johnson's hairstreak in the Blue Mountains (Hawksworth & Wiens 1996).

[1] Dwarf mistletoe hosts occurring in the Blue Mountains.

Primary host species	Mean shoot height	Max shoot height	Mean basal diameter	Max basal diameter
Western hemlock	**7 cm**	**13 cm**	2 mm	N.A.
***Ponderosa pine[1]/Jeffrey pine**	**8 cm**	**13 cm**	3 mm	5 mm
*Digger pine	8 cm	12 cm	2 mm	4 mm
Pinyon pine	8 cm	13 cm	2 mm	4 mm
White fir	10 cm	22 cm	2 mm	6 mm
Lodgepole pine[1]	5-9 cm	30 cm	1.5 mm	5 mm
Western larch[1]	4 cm	6 cm	2 mm	3 mm
Douglas-fir[1]	2 cm	8 cm	1 mm	1.5 mm

Mistletoe-feeding hairstreak larvae mimic their host plants (Figure 1). Dwarf mistletoe of Douglas-fir in particular is very small (Figure 2). This makes the mimicry less effective and also increases food search time for the larvae. For these reasons it is not likely to be a preferred host. Based on size and use by thicket hairstreaks, larch and lodgepole pine dwarf mistletoes may be

Figure 1: Two hairstreak larvae on ponderosa pine dwarf mistletoe (Spiegel, USFS).

Figure 1: Douglas-fir dwarf mistletoe. Note plants barely larger than needles, scattered along the branch (Robert James, USFS).

acceptable hosts for Johnson's hairstreak but they have not yet been documented. Johnson's hairstreak has been documented as high as 6700' in the Sierras and could occur in the range of lodgepole pine dwarf mistletoe in the Blue Mountains (Shields 1965).

The Blue Mountains do not host western hemlock and the forests are much drier and more open than the places Johnson's hairstreaks have been found to the west. Although grand/white fir occurs here, dwarf mistletoe on these trees does not occur in the Blue Mountains. While

much of the literature indicates that this butterfly is dependent on large, closed-canopy old-growth (Pyle 2002; Miller & Hammond 2007), this is based on collections and sightings in the moist fir/hemlock forests of the Cascades and West Coast. Forests providing western dwarf mistletoe (*Arceuthobium campylopodum*) habitat in the Blue Mountains are typically open to provide sun that allows ponderosa pine to regenerate. Some of the confusion likely results from early mistletoe names that have since been revised. For example, dwarf mistletoe on hemlock previously had the same species name as the dwarf mistletoe species on ponderosa pine (Shields 1965).

Dwarf mistletoe biology and distribution

Trees can become infected with dwarf mistletoe throughout their lives. Ponderosa pines infected for many years produce large, clumpy "brooms" or groups of clustered branches near the infection site. The size of the dwarf mistletoe plants does not appear to be related to tree age but may be related to tree condition, with more vigorous trees producing larger clumps. When ripe, western dwarf mistletoe seeds are forcibly expelled up to 75 feet from the plants. They are predominantly spread from overstory trees to understory trees within about 30 feet. The sticky seeds are also spread when they become attached to birds' feathers or animals' fur and become detached onto host trees (Schmitt 1996). The aerial shoots of western dwarf mistletoe are evident within 3-6 years of infection (Hawksworth & Wiens, 1996). Stands with an infected pine overstory growing over a younger age class of pines typically have visible infections in all ages of trees.

Dwarf mistletoes are well-represented in many stand types in the Blue and Wallowa Mountains. Table 2 displays incidence of dwarf mistletoes by proportion of trees infected and average Dwarf Mistletoe Rating from the Current Vegetation Survey (CVS) plot record (Schmitt 2002). This indicates that around 7.5% of ponderosa pines in Northeastern Oregon are infected.

Table 2: Dwarf mistletoe occurrence and severity in the Blue and Wallowa Mountains 2002 CVS (Continuous Vegetation Survey) plot data.

		Umatilla NF	Wallowa-Whitman NF	Malheur NF
Lodgepole pine dwarf mistletoe	% Plot host trees infected	13.6%	6.6%	13.5%
	Average DMR of infected trees	1.86	2.66	2.54
Western dwarf mistletoe	% Plot host trees infected	6.0%	8.3%	8.5%
	Average DMR of infected trees	2.37	3.03	2.84
Douglas-fir dwarf mistletoe	% Plot host trees infected	13.6%	18.7%	17.1%
	Average DMR of infected trees	2.73	3.45	2.78
Western larch dwarf mistletoe	% Plot host trees infected	10.5%	27.2%	17.7%
	Average DMR of infected trees	3.0	3.53	2.39

Severity of dwarf mistletoe infection has been standardized west-wide with a 6-class rating system. The system for Dwarf Mistletoe Rating (DMR) is easily learned and can be applied to individual trees and averaged for stands (Hawksworth 1977).

Infected trees are rated as follows:

1) Visually divide the live crown into thirds (top, middle, and bottom).

2) Rate each third separately as--

0= no visible infection

1= light infection; one-half or less of the branches have infections

2= heavy infection; more than one-half of the branches have infections

3) Add the ratings for each crown third to obtain the rating for the tree.

Trees rated 1 or 2 are considered lightly infected; 3 or 4 moderately infected; 5 and 6 severely infected (Schmitt 1996).

Hessburg and others (1999) investigated changes from historical to current insect and disease vulnerabilities of selected subbasins within the Columbia River Basin, including subbasins in the Blue Mountains Ecological Reporting Unit, which covers the area reported to host Johnson's Hairstreak. This is probably the best available data for approximating changes from historical to current insect and disease occurrence at the watershed level.

These authors found that the area of patches vulnerable to Douglas-fir dwarf mistletoe disturbance increased by 63 percent from 10.1 to 16.5 percent, with patch density more than doubling from 9.3 to 19.6 patches per 10,000 ha, and mean patch size increasing from 87.5 to 125.7 ha.

They found that area and connectivity of patches vulnerable to western (ponderosa pine) dwarf mistletoe disturbance declined. Percentage of area declined by 22 percent from 10.4 to 8.1 percent, with patch density increasing from 9.6 to 12.7 patches per 10,000 ha, and mean patch size decreasing from 83.8 to 59.8 ha.

They also found area and connectivity of patches vulnerable to western larch dwarf mistletoe disturbance declined. Percentage of area declined by 38 percent from 1.3 to 0.8 percent, with patch density increasing from 1.8 to 3.6 patches per 10,000 ha, and mean patch size decreasing from 16.0 to 9.8 ha.

They found area and connectivity of patches vulnerable to lodgepole pine dwarf mistletoe disturbance increased. Percentage of area increased by 7 percent from 1.5 to 1.6 percent, with patch density increasing from 2.9 to 4.0 patches per 10,000 ha, and mean patch size increasing from 21.5 to 21.8 ha.

These changes from historical dwarf mistletoe vulnerability reflect the changes in area of the various host species. The widespread logging of seral ponderosa pine and larch trees has reduced their dominance on the landscape. The additional removal of widespread fire has promoted the regeneration and growth of Douglas-fir and true firs in many stands previously dominated by ponderosa pines and larch. Ponderosa pine now occurs less frequently in single species or ponderosa pine-dominated stands and now occurs more frequently in mixed species stands.

In shade-tolerant species such as hemlocks and true firs dwarf mistletoes can intensify and cause severe infections. However those dwarf mistletoes do not occur in the Blue Mountains. The host of the known larval food plant in the Blue Mountains is seral ponderosa pine and it will not spread to non-host understory that regenerates in dense stands.

The Hessburg analysis reveals the slow decline of dwarf mistletoe-infected ponderosa pine through the loss of much of the pine overstory and the encroachment of shade-tolerant species into once pine-dominated stands. The maintenance of healthy populations of Johnson's hairstreak requires the maintenance of ponderosa pine (and possibly western larch).

Maintaining or reestablishing ponderosa pine in areas where it historically dominated will require opening stands currently dominated by recent grand fir and Douglas-fir ingrowth (Haugo et al. 2015; Merschel et al. 2014). Historically light surface fires in seral stands killed trees with low-hanging dwarf mistletoe brooms, but trees with elevated brooms survived. Stands that are dense with fir regeneration and low-growing crowns will now experience more severe fire when they burn. Especially hot fires can effectively sanitize stands of dwarf mistletoe when all infected trees are killed. Significant reinfection then will take decades as birds reintroduce seeds and the infection slowly spreads. No action over the long term would result in less hairstreak habitat.

Historical and recent surveys show that Johnson's hairstreak is not common but is well-distributed on the south sides of the Wallowas in dwarf-mistletoe infected ponderosa pine forests. Targeted surveys in 2009 confirmed two new locations in both low and high probability areas (http://www.butterfliesandmoths.org/species/Callophrys-johnsoni).

Thinnings that target stands for dwarf mistletoe reduction would likely result in some direct reduction of Johnson's hairstreak individuals but would not impact the ability of the species to survive in the Blue Mountains. To ensure the continued wide distribution of this species, it is recommended that patches of dwarf mistletoe infected pines be left across the landscape. The promotion of ponderosa pine will provide feeding habitat for the long-term survival of the Johnson's hairstreak.

Addendum:

This report provides some updated information on Johnson's hairstreak butterfly in the Blue Mountains. A letter sent out from this office dated April 16, 2008 (Schmitt & Spiegel 2008) provided some of this information. Following renewed questions on the habitat of Johnson's

hairstreak, I thought it important to provide this information anew as many of the people interested in these butterflies have changed. Also, I conducted some surveys for Johnson's hairstreak butterflies in 2009 and 2010 and documented a few additional locations on the southwest side of the Wallowas.

This report, combined with the information in the 2008 letter, should answer many of the questions regarding this species, its possible distribution, and its possible and documented larval host plants.

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